

Nuclear fission

Nuclear fission:

The process in which a heavy nucleus (mass number >200) divides to form smaller nuclei of intermediate mass and one or more

Note that

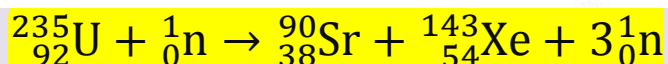
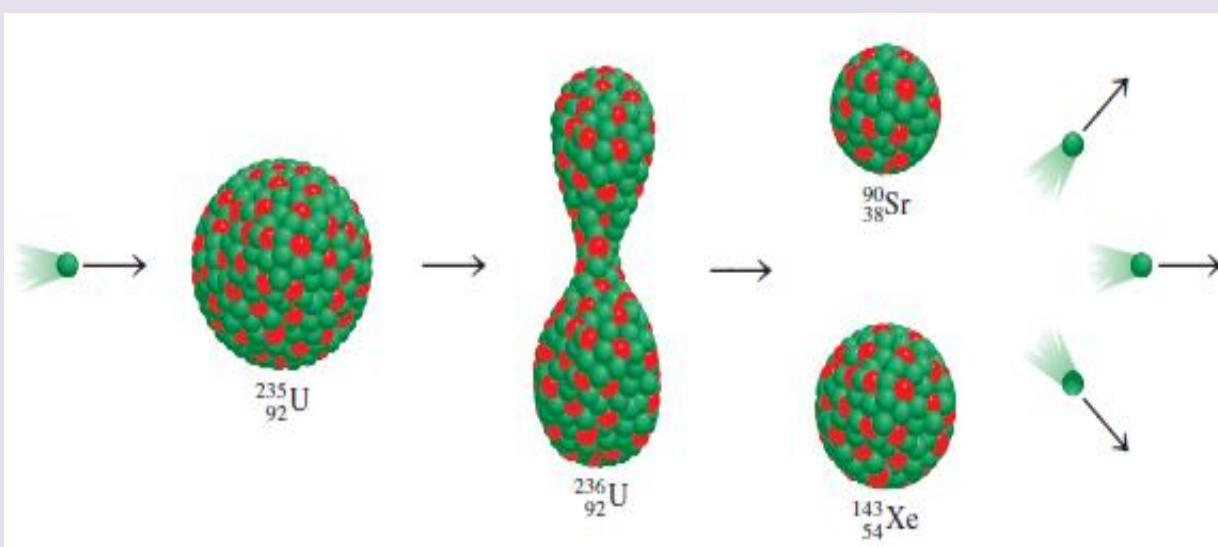
- ✓ This process releases a large amount of energy **why?!**

Because the heavy nucleus is less stable than its product.

Example

Uranium 235 bombarded with slow neutron.

This reaction is very complex.



- ✓ The binding energy per nucleon for uranium 235 is less than the sum of binding energies for strontium 90 and Xenon143.
- ✓ This reaction is **exothermic reaction**.
- ✓ The significant feature of uranium 235 fission isn't the enormous amount of energy released but the fact that more neutrons are produced than are originally captured in the process, this property makes possible (**Nuclear chain reaction**).
- ✓ For a chain reaction to occur enough uranium 235 must be present in the sample to capture the neutrons.

The critical mass

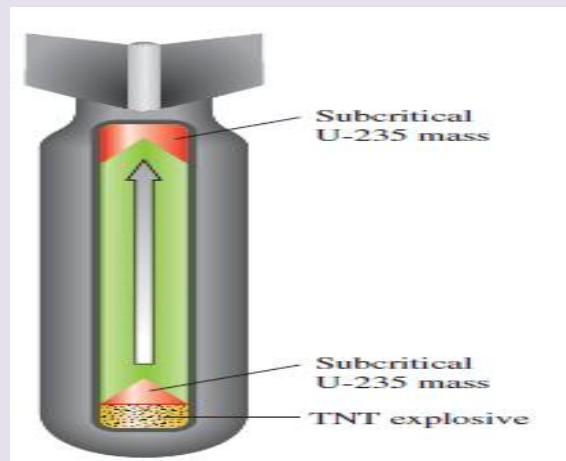
→ The minimum mass of fissionable material required to generate a self-sustaining nuclear chain reaction.

1) The atomic bomb

Notes

- The first application of nuclear fission was in the development of the atomic bomb.
- The crucial factor in the bomb's design is the determination of the critical mass for the bomb.

An atomic bomb: → is never assembled with the critical mass already present. Instead, the critical mass is formed by using a conventional explosive such as TNT to force the fissionable sections together.



Neutrons from the source at the center of the device.

Trigger the nuclear chain reaction Uranium 235 was the fissionable material in the bomb dropped on Hiroshima.

2) Nuclear reactors

A peaceful but controversial application of nuclear fission is the generation of electricity using heat from a controlled chain reaction in a nuclear reactor.

Notes

Nuclear reactors provides about 20 present of the electrical energy in the united states.

Several different types of nuclear reactors are in operation.

3) Light water reactors

An important aspect of the fission process is the speed of the neutrons

Note that

1) Slow neutrons split uranium 235 nuclei more fervently than do fast ones?? **Rationalize**

Because fission reactions are highly exothermic.

Moderators

Substances that can reduce the kinetic energy of neutrons.

It should be

- 1) Nontoxic and in expensive.
- 2) Resist conversion into a radio active substance by neutron bombardment.
- 3) A fluid so that it can also be used as a coolant.

2) Nuclear reactors that use light water as a moderator is called light water reactors because ${}^1_1\text{H}$ are the lightest isotope of the element hydrogen.

The nuclear fuel consists of uranium usually in the form of its oxide (U₃O₈).

The main difference between an atomic bomb and a nuclear reactor is that the chain reaction that takes place in a nuclear reactors is kept under control at all times.

The factor limiting the rate of the reaction is the number of neutron presents.

4) Heavy water reactors

Uses D₂O or heavy water as a moderator.

Notes

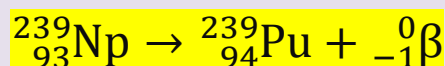
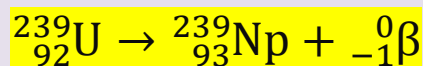
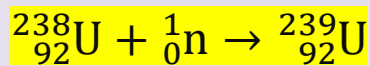
- Deuterium absorbs neutrons much less efficiently than does ordinary hydrogen.
- The reactor is more efficient and doesn't require enriched uranium.

The main advantages of a heavy water reactor is that it eliminates the need for building expensive uranium enrichment facilities.

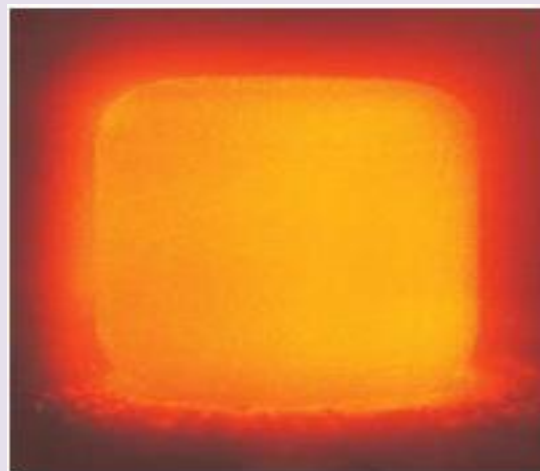
- The fact that no enriched uranium is required in a heavy water reactor enables a country to enjoy the benefits of nuclear power without under taking work that is closely associated with weapons technology.

5) Breeder reactors

Uses uranium fuel but it produces more fission able materials than it uses uranium-238 is bombarded with fast neutrons



- The non-fissionable uranium 238 is transmuted into the fissionable isotope plutonium.



In a typical breed reactor, nuclear fuel containing uranium-235 or plutonium 239 is mixed with uranium, 238 so that breeding takes place within the core.

There are more than one neutron is captured by U238 to generate plutonium 239.

The development of breeder reactors has been very slow.

Note that

- Breeder reactors are more expensive to build the conventional reactors
- There are more technical difficulties associated with the construction of such reactors.

6) Hazards of nuclear energy

- Plutonium -239 used as a nuclear fuel and produced in breed reactors, is one of the most toxic substances Known.

The problem of radioactive waste disposal hasn't been sat is factory resolved even for safely operated nuclear plants

Because of the hazards, the future of nuclear reactors is clouded

Choose

1) The process in which a heavy nucleus divides to form smaller nuclei of intermediate mass and one or more neutron is.....

- A) Nuclear Fusion
B) Nuclear fission
C) Fusion reactor
D) tracers

2) The binding energy per nucleon for uranium 235 is Than the sum of the binding energies for strontium and Xenon-143.

- A) less
B) More
C) equal
D) None of all

3)is the minimum mass of fissionable material required to generate a self-sustaining nuclear chain reaction.

- A) Atomic number
B) Binding energy
C) The critical mass
D) mass number

4) Is never assembled with the critical mass already present but it is formed by using a conventional explosive such as TNT.

- A) Nuclear reactor
B) Light water reactor
C) Atomic bomb
D) Heavy water reactor

5) Provides about 20 percent of the electrical energy in the united states.

- A) Nuclear reactor
B) Light water reactor
C) Atomic bomb
D) Heavy water reactor

6) Substances that can reduce the Kinetic energy of neutron is.....

- A) tracers
- B) Plasma
- C) moderators
- D) Breeder reactors

7) uses D_2O or heavy water as a moderator

- A) Light water reactor
- B) Nuclear reactor
- C) Breeder reactors
- D) Heavy water reactor

8) The advantages of Is that is eliminates the need for building expensive uranium enrichment facilities

- A) Heavy water reactor
- B) Light water reactor
- C) Breeder reactors
- D) Nuclear reactor

9) Uses uranium fuel but it produces more fissionable materials than it uses.

- A) Heavy water reactor
- B) Breeder reactors
- C) Light water reactor
- D) Nuclear reactor

10) In..... nuclear fuel containing uranium-235 or plutonium-239 mixed with uranium-238

- A) Heavy water reactor
- B) Light water reactor
- C) Breeder reactors
- D) Nuclear reactor

11) In..... plutonium-239 used as a nuclear fuel

- A) Hazards of nuclear energy
- B) Heavy water reactor
- C) Light water reactor
- D) Nuclear reactor

12) What role cadmium metal (Cd) play in a nuclear reactor?

- A) Slow down the fission neutrons (moderators)
- B) Transfers heat from the reactor to the heat exchanger
- C) Controls chain reaction (fuel rods)
- D) Transfers heat from the condenser to the environment.

13) Which of the following is an advantage of nuclear power plants over coal-burning plants? Nuclear power plants

- A) From numerous radioactive fission products
- B) Use more fuel
- C) Produce more thermal pollution than coal plants
- D) Don't pollute the air with SO_2 , soot and flu-ash